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Australian renewable energy progress

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ABSTRACT

With some of the world's best solar and wind resources, Australia is a prime market for solar and wind energy. The growing renewable energy industry can take advantage of Australia's stable economy, good access to grid infrastructure and well organised financial and legal services.

Although development has been slower than what was anticipated, but with the promises made by the new government, the renewable community hopes for a brighter future for solar and wind energy in Australia.

The objective of this paper is to present an overview of the current status of solar and wind energy in Australia, then to take a closer look at solar and wind potential, current activities, and finally to discusses about Australian Government support and to predict the future outlook of solar and wind energy.

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Contents

1. Introduction

Meeting growing energy demand, securing energy supply, and reducing emissions are the main challenges world is facing today. Many governments around the world have committed to reduce their GHG emissions. They have decided to strengthen their national efforts to increase the utilization of renewable energy sources. There are a variety of renewable energy technologies available, but two of them namely solar and wind have attracted more attention. World's wind power capacity has increased by factor 12 between 1998 and 2008. Similar growth has been observed in the world's solar power. These data suggest that solar and wind have been success story of the past two decades.

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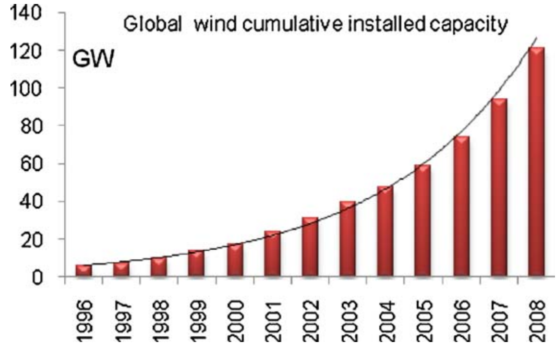


Fig. 1. Global installed capacity (cumulative).

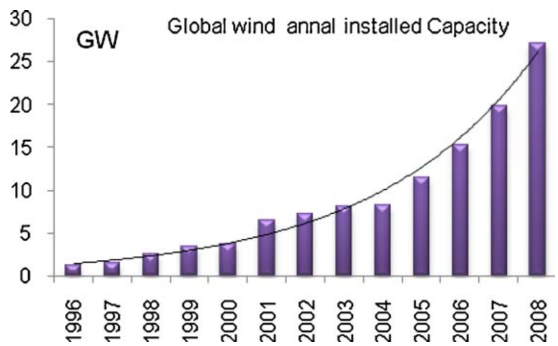


Fig. 2. New annual installations.

2. Global wind energy

Globally, wind power is booming. Total installed capacity at the end of 2008 exceeds 120 GW [1]. Fig. 1 shows exponential growth of global wind energy. Fig. 2 shows the new installations of wind power every year. When we look at the wind power development in the past decade we see that global wind energy capacity has increased from 6000 MW in 1996 to 120,000 MW in 2008, meaning an increase by factor 15 or growing at annual average rate of 25.3%. This significant growth of wind energy utilization is driven by a number of factors, including impressive improvement in the wind turbine technology, rising environmental concern, especially climate change, and desire for less dependency on non-renewable sources of energies.

In order of installed capacity in 2008, the leading countries (top ten) with highest wind power were: the USA (25.2 GW), Germany (23.9 GW), Spain (16.8 GW), China (12.2 GW), India (9.6 GW), Italy (3.7 GW), France (3.4 GW), UK (3.2 GW), Denmark (3.1 GW), Portugal (2.8 GW), and rest of the world (16.7 GW) [1].

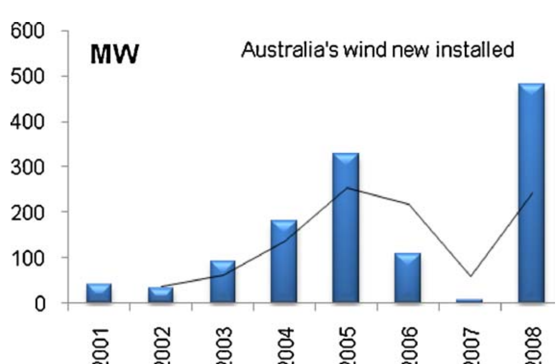


Fig. 3. Annual installed capacity.

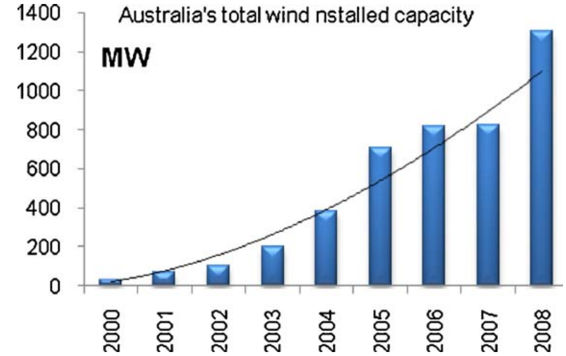


Fig. 4. The cumulative wind power capacity.

In terms of economic value, the global wind energy market in 2008 was worth about US$52 billion. The wind industry also created many new jobs. Over 400,000 people are now employed in the wind industry and expected to reach one million in near future [2].

3. Wind energy in Australia

Australia currently has 42 wind farms in operation with more under construction [3]. Total operating wind capacity at the end of 2007 was 824 MW total power of 563 wind turbines installed across Australia. In addition, nine projects with a total capacity of over 860 MW were in various stages of construction [4]. Significant wind capacity is also moving through the planning stage, with over 400 MW receiving planning approval during 2007. Fig. 3 shows the new installations of wind power every year in Australia and Fig. 4 shows Australia's cumulative wind power capacity. Delay in approving process created a big gap as shown in Fig. 3.

The new government has increased Australia's national target of 2% of electricity to come from renewable energy by 2020 up to 20% [5]. This target will require around 10,000 MW of new renewable energy projects to be built over the next decade. The Australian Government intends to implement an expanded Renewable Energy Target (RET) scheme, with an ultimate target in 2020 of 45,000 GWh. The wind industry is poised to play a major role in meeting this demand.

With 51% of Australia's wind energy, South Australia is the leading state in terms of wind energy installed. Wind power currently provides about 0.5% of Australia's electricity requirements, but this could easily rise as high as 20%.

4. Global solar energy

Since 1994, worldwide solar PV market has experienced enormous growth. In fact, since 1994 the PV global market has increased by factor of 20. By end of 2007 the cumulative installed

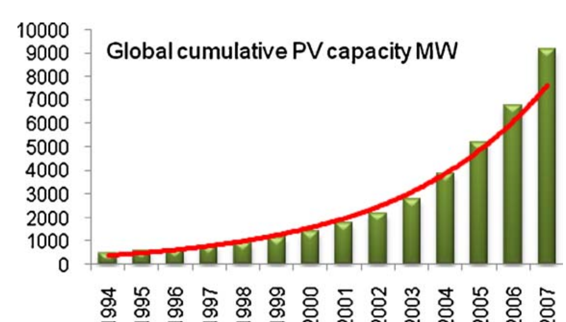


Fig. 5. Global cumulative PV capacity, MW.

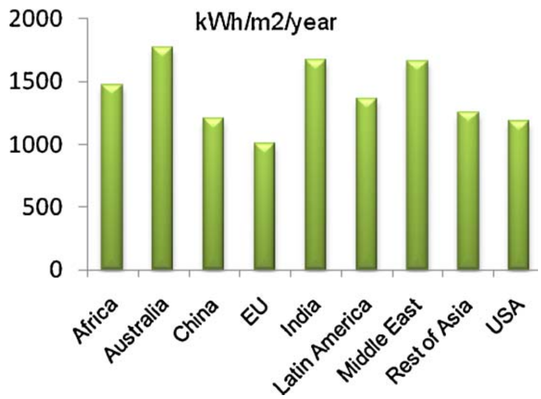


Fig. 6. World's highest sun radiation.

capacity of solar PV system reached 9200 MW, worldwide [6]. This was about 500 MW at the end of 1994. The global development of PV capacity has been shown in Fig. 5. According to this figure, installation of solar PV system has been growing at an annual average of more than 25% since 1994. Experts believe that through increased production volume and improved PV technology we will observe a much faster increase in solar PV market.

5. Electricity generation in Australia

In Australia, fossil fuel is the main source for generating electricity. The pollution from coal-fired power stations is the main contributor to the problem of global warming. In 2004, for example, 91% of the amount of electricity generated in Australia came from 24 fossil fuel power stations around Australia. This is equivalent to about 200 million tonnes of carbon pollution [7]. Renewable energies and clean-energy technologies such as solar have the potential to play a significant role in the Australia's energy supply. As shown in Fig. 6 the level of sun radiations in Australia is highest compared with other regions. This indicates that Australia has potential to cover high percentage of its energy demand by solar energy. Comparing population of Australia with population of the other regions suggests that solar radiation per capita in Australia by far is the highest in the world.

6. Solar energy technologies in Australia

The solar energy technologies currently available and used in Australia include:

- conventional solar photovoltaic,
- solar photovoltaic plus mirrors,
- solar concentrators,
- solar dish,
- solar pond, a 60 kW system installed in Pyramid Hill, Victoria, and
- solar steam turbine.

Solar PV technology accounts for almost 70% of installed capacity of solar energy in Australia. Again, South Australia is the leading states in terms of solar PV installation.

7. Disturbing fact

Between the mid-1990s and 2007, the Australia PV market went from 13% to 0.5% of the market in IEA countries. In the mid-1990s Australia was the 4th largest world manufacturer of PV cells. It now has no production. Between 1992 and 2004 prices for small grid-connected PV systems decreased by 35% in Germany, 54% in Japan, 30% in the US, but remained static in Australia [8].

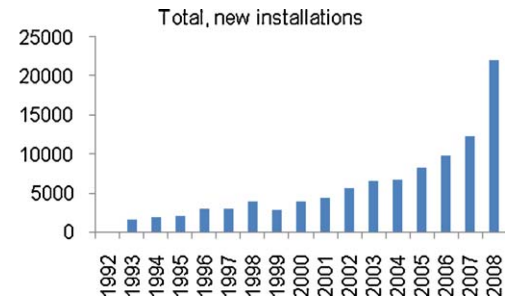


Fig. 7. New installed PV power in Australia.

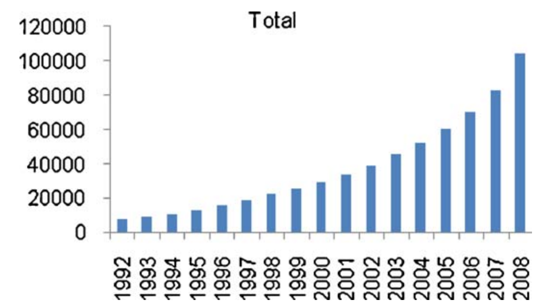


Fig. 8. The cumulative installed PV power in Australia.

8. Solar PV powering Australia

Total current installed capacity in Australia is 104.51 MW [5]. Since 2004 the installed capacity has experienced an increase of 100%. A total of 22.02 MW of PV were installed in Australia in 2008, an 80% increase on 2007 levels (in comparison, during the same period Spain installed 2700 MW of solar PV power (PVPS)). Of this, nearly 69% was grid connected, taking the cumulative grid-connected portion to nearly 30%, up from 19% in 2007 (Muriel).

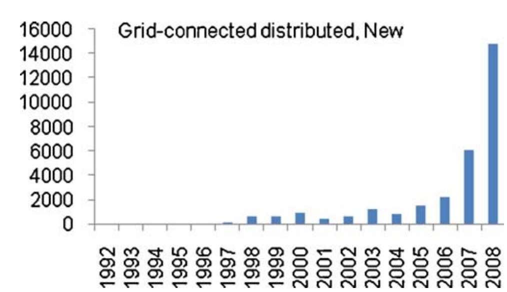


Fig. 9. New installations of grid-connected distributed PV.

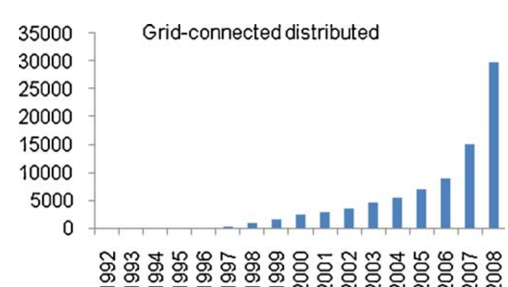


Fig. 10. The cumulative grid-connected distributed PV.

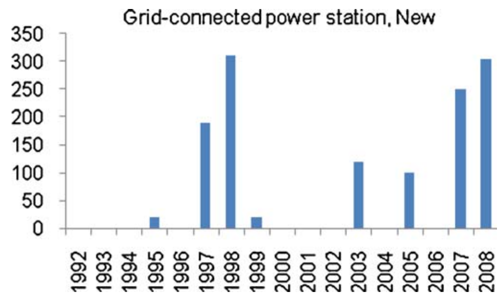


Fig. 11. New installations of grid-connected power station.

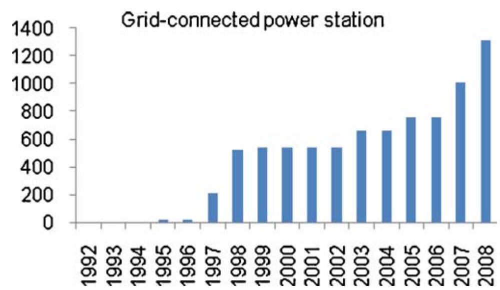


Fig. 12. The cumulative grid-connected power station.

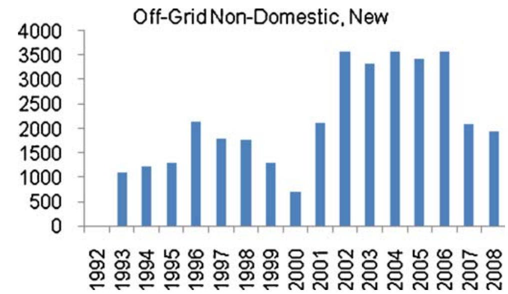


Fig. 15. New installations of off-grid non-domestic PV.

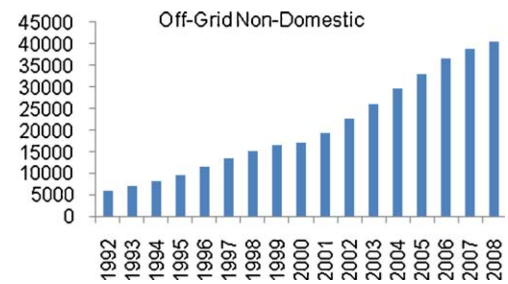


Fig. 16. The cumulative off-grid non-domestic PV.

The application of solar PV power in Australia can be divided in five sectors as following [5]:

1. grid-connected distributed PV system,
2. grid-connected power station,
3. off-grid domestic,
4. off-grid non-domestic, and
5. diesel grid.

Fig. 7 shows the new installations and Fig. 8 shows the total cumulative installed PV of all these five sectors in Australia.

Fig. 9 shows the new installations of grid-connected distributed PV and Fig. 10 shows the total cumulative grid-connected distributed PV. It can be observed from these figures that there is a significant increase in grid-connected distributed systems from 2007 to 2008. This is mainly because, high Government support granted for rooftop PV systems.

Fig. 11 shows the new installations of grid-connected PV power stations and Fig. 12 shows the total cumulative grid-connected PV power stations in Australia. Low or non-activities and also inconsistency in the program in some years are noticeable.

Fig. 13 shows the new installations of off-grid domestic PV system and Fig. 14 shows the total cumulative off-grid domestic PV system. It can be observed from these figures that there is a consistency in growth in this sector with a total of 31 MW installed capacity Australia wide.

Off-grid non-domestic is the largest installed capacity of PV in Australia. PV systems in this sector are used for power supply for remote services such as telecommunications, lighting, signalling, water pumping, speed limit signs, etc. Fig. 15 shows the new installations of off-grid non-domestic PV system and Fig. 16 shows the total cumulative off-grid non-domestic PV system. It can be observed from these figures that there is consistency in growth in this sector with a total of 41 MW installed capacity Australia wide.

Diesel grid PV are those systems connected to mini diesel grids, with total installed capacity of about 2 MW. Fig. 17 shows the new installations of diesel grid and Fig. 18 shows the total cumulative diesel grid PV system.

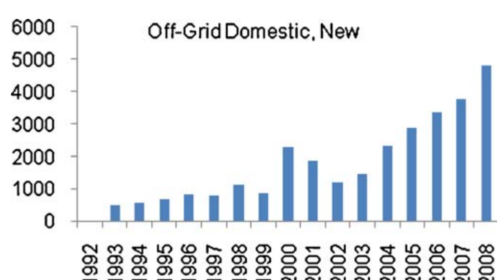


Fig. 13. New installations of off-grid-domestic PV.

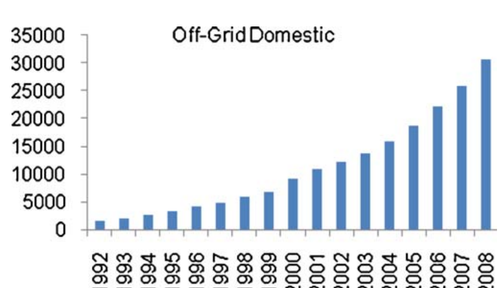


Fig. 14. The cumulative off-grid-domestic PV.

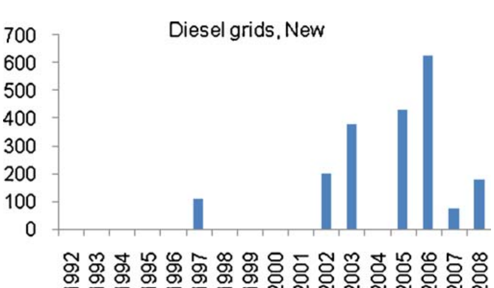


Fig. 17. New installation of diesel grid PV.

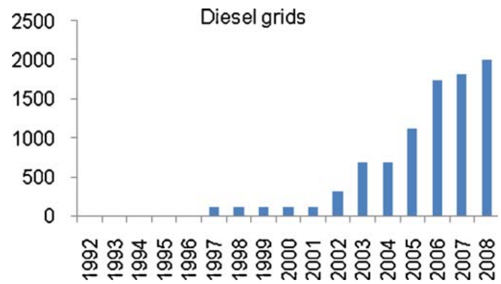


Fig. 18. The cumulative diesel grid PV.

Table 1
Feed-in tariff implemented currently in Australia [11].

	Rate gross	Rate net	Maximum size	Contract
ACT	$0.50/kW h (10 kW) $0.4/kW h (10–30 kW)	–	30 kW	20 years
NSW	$0.60/kW h	–	10 kW	7 years
NT	–	–	–	–
QLD	–	$0.44/kW h	10 kW	2028
SA	–	$0.44/kW h	10 kW	2028
TAS	–	–	–	–
VIC	–	$0.60/kW h	5 kW	15 years
WA	–	–	–	–

9. Government initiatives

Australian Government has a wide range of solar PV programs and initiatives. Green Loans is a new Australian Government initiative to help Australians tackle climate change.

The Green Loans Program assists Australian families to install solar, water saving, and energy efficient products. The Green Loans Program provides detailed, quality Home Sustainability Assessments; and access to Green Loans of up to $10,000, that are interest free for up to a maximum of 4 years, to make the changes recommended in the assessment [9].

10. Green start program

Green Start is a $130 million initiative to help improve the energy and water efficiency of low income and disadvantaged households.

11. Smart grid, smart city program

The Australian Government has committed up to $100 million to develop the *smart grid*, *smart city* demonstration project in partnership with the energy sector [9].

12. Australia's solar cities program

The main objective of the Australia's solar city program is to demonstrate the environmental and economic effects of combining cost reflective pricing with the widespread use of solar energy technology, energy efficiency and smart metering devices. A further objective of the program is to find out what barriers exist in relation to energy efficiency, energy demand management and the use of solar technology, among householders and businesses in different parts of Australia, and to examine the ways to deal with these barriers.

The selected Australia's solar cities are: Adelaide, Alice Springs, Blacktown, Central Victoria, Moreland, Perth, and Townsville. Each solar city will integrate a unique combination of energy options such as the use of solar PV technologies, energy efficiency measures for homes and businesses, cost reflective pricing trials to reward people who use energy wisely, and community education about better energy usage in an increasingly energy-reliant world.

12.1. Renewable energy fund (REF)

The aim of renewable energy fund is to accelerate commercialisation and deployment of renewable energy technologies in Australia. The $500 million REF funds is available on a 1:2 basis, with the aim of leveraging over $1.5 billion in renewable energy investment to assist Australia to achieve its 20% renewable electricity target by 2020 [5].

12.2. Australian solar institute

$100 million over 4 years has been allocated to the establishment of an Australian Solar Institute, which is to cover PV and solar thermal electric research [5].

13. Townsville's solar city project

Townsville is an ideal place for a solar city. This is mainly because this city receives approximately 300 days of sunshine each year. The Townsville solar city project includes: installing 500 solar PV systems on business and residential buildings (total capacity of about 0.8 MW); Installing 1700 smart meters; offering free 'ecoMeter' in-house displays, which work with smart meters to show electricity consumption. Smart meters measure electricity in 30 min time intervals. When used in conjunction with an 'ecoMeter' in-house display, house owners can determine not only how much electricity they use, but also when they should use it [10].

14. Feed-in tariff in Australia

Prior to the introduction of feed-in tariffs, most electricity retailers in Australia offered net metering for small residential PV systems.

New South Wales and ACT have now implemented gross feed-in tariffs, while Victoria, South Australia, and Queensland have implemented net export feed-in tariffs. Feed-in tariffs in Australia are not taxable income. Table 1 shows the feed-in tariff implemented in different states and territories in Australia.

15. Issues with solar and wind energy

The specific nature of solar and wind power as variable generation sources requires specific implementation of new technology and grid management concepts.

Size of solar rooftop PV system are limited to the size of the roof, so usually are in the range of kW with minimal impacts on the electricity grid. However, high level of penetration of solar and wind energy might have some impacts on grid stability, congestion management. Output power variations of solar and wind energy might cause power quality issues.

The main problem with large-scale solar and wind energy is the grid. The conventional electricity grids are designed to supply and deliver electricity to the customers in one direction of power flow. These grids are not designed to absorb electricity produced by distributed generators, especially from renewable sources, whose output power cannot be controlled by power system. We need modern, up-to-date and smarter grid. One of many weaknesses that traditional grids have is lack of enough flexibility to give access to new power generators such as solar and wind to be integrated into the grid. There is need for a network, which is more accessible

to provide connection access to all network generators, particularly for renewable power sources.

16. Storage options

There is currently considerable interest in energy storage technologies combined with renewable energy sources to meet the growing demand for electricity. Many storage technologies have been considered in both small-scale and large-scale. These include:

- batteries (including conventional and advanced technologies),
- fuel cell/electrolyser systems,
- superconducting magnetic energy storage (SMES),
- flywheels,
- pumped hydro, and
- super-capacitors.

Each of these technologies has its own particular operational characteristics. For example, pumped hydro is best suited for large-scale bulk electrical energy storage. On a small scale storage options include flywheels, batteries, fuel cells, electrolysis and super-capacitors.

17. Conclusions

This paper has presented results of a study conducted on wind and solar activities in Australia with a closer look at the annual developments of these two energies. In terms of solar PV market, manufacturing, exporting, Australia has been more significant at global level in the 1990s compared with present decade. Without any doubt, Australia leads the world in many areas of PV research, development, and innovation. With the new Government initiatives, the renewable energy community is hoping for a brighter future.

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